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Innovation Trajectories in Developing Countries: Co-evolution of Global Value Chains and Innovation Systems

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Abstract This article investigates how combining global value chain and innovation system approaches can help to foster an understanding of the possible trajectories that learning and innovation may take in developing countries. Based on the wealth of empirical evidence collected in the special issue, we introduce the notion of the co-evolution of global value chains and innovation systems and outline a framework for investigating the interaction between the two in a dynamic perspective with multiple trajectories. We find that, in some cases, there is an improvement in local innovation capabilities with potentially positive effects on overall competitiveness, while in others there is little progress or even a loss of previous innovation capacity.

Cet article explore comment la combinaison d'approches liées aux chaînes de valeur mondiale et aux systèmes d'innovation peut aider à comprendre les trajectoires possibles de l'apprentissage et de l'innovation dans les pays en développement. Sur la base d'une multitude de preuves empiriques collectées dans ce numéro spécial, nous introduisons la notion de co-évolution des chaînes de valeur mondiales et des systèmes d'innovation et décrivons un cadre pour étudier l'interaction entre les deux dans une perspective dynamique avec trajectoires multiples. Nous constatons que, dans certains cas, il y a une amélioration des capacités locales d'innovation avec des effets positifs potentiels sur la compétitivité globale, tandis que dans d'autres il y a peu de progrès ou même une perte de capacité d'innovation.

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Keywords: global value chain; innovation system; co-evolution; trajectories; innovation; learning; developing countries

Introduction

It is widely recognised that learning and innovation are fundamental prerequisites for sustainable economic growth and development (Cimoli *et al*, 2009). In this respect, developing countries are faced with significant challenges in building and deepening their technological and innovation capabilities, in forming appropriate skills and in strengthening the related supporting institutions to increase overall competitiveness (Lundvall *et al*, 2009). Given the growing global interconnectedness, it is still an open question whether, and under what circumstances, globalisation creates new opportunities for learning and innovation in developing countries or, conversely, can become a hindrance for the building up of their innovation capabilities.

In light of increasing globalisation[1], many low and middle-income countries are stuck at the bottom of the ladder due to their economic specialisations, driven by global trade and export demand. In particular, middle-income countries are often trapped; they face the challenge of sustaining structural transformation with rising wages, but possess low knowledge bases and encounter difficulties in the formation of the kinds of capabilities required to expand further into greater value-added activities (Nübler, 2014; Paus, 2014). Nevertheless, some countries have been able to take advantage of current opportunities to acquire external resources, which have been key to building up the capabilities needed for further development.

Building on the wealth of the empirical evidence collected in this special issue, this article investigates how combining global value chain (GVC) and innovation system (IS) approaches can help to foster an understanding of the possible trajectories of learning and innovation in developing countries. The GVC and IS approaches are relational in nature and complement each other by drawing attention to linkages and interactions between heterogeneous actors. However, they do not provide much understanding of dynamics. In order to fill this gap, we introduce the notion of the co-evolution of GVC and IS and outline a framework for investigating the interaction between the two in a dynamic perspective with multiple possible trajectories. On a continuum, the pathways range from a progressive (*gradual trajectory*) mutual co-evolution to an outright negative (*retrograding trajectory*), which might occur if the innovation system is too weak to sustain competitiveness in the face of changes of global demand and value chain configurations. Inbetween, there are different possible pathways, such as the case when the IS is relatively weak and fragmented and GVCs fail to provide learning opportunities for progressing beyond given circumstances, leading to a stagnation (*aborted trajectory*), or instances in which such circumstances can be overcome by disconnecting from the GVCs to connect to a well-developed IS before re-entering GVCs from a new and strengthened position, in terms of capabilities (*in–out–in trajectory*).

The articles included in this special issue shed light on the co-evolutionary relationships by presenting original quantitative and qualitative evidence. The papers further the existing literature in three main ways: (1) they offer new insights into how learning and innovation occurs in GVCs (especially De Marchi *et al*, 2018; Haakonsson and Slepniov, 2018; Tajoli and Felice, 2018); (2) they investigate the role of innovation systems (and policy) in determining benefits from participating in GVCs (in particular Fagerberg *et al*, 2018; Gehl Sampath and Vallejo, 2018; Jurowetzki *et al*, 2018; Keijser and Iizuka, 2018; Pietrobelli and Staritz, 2018); and (3) they illustrate some of the possible trajectories of GVC and IS co-evolution (specifically Humphrey *et al*, 2018; Lee *et al*, 2018).

The remainder of this introductory article is organised as follows: The next section (The global value chain approach) reviews the relevant literature on global value chains with an emphasis on how they foster learning at the firm level. The paper then proceeds with a section (Developing country innovation systems in the global economy) that reviews the innovation systems approach and its strengths and weaknesses as a tool to analyse innovation in developing countries. We move thereafter to the core of the paper. The section entitled 'The co-evolution of global value chains and innovation systems' introduces a conceptual framework to investigate the possible co-evolving trajectories of GVC and IS. In the final section, we conclude by posing questions for future research (Final remarks).

The Global Value Chain Approach

In recent decades, the nature of international trade flows has changed dramatically with trade in parts, components and services increasing in importance with respect to final goods. Thanks to

the extraordinary advances in transportation modes and communication and information technologies, world production is now more and more dispersed across national borders and undertaken by firms organising their production process in stages such as design, assembly and distribution within global value chains. GVC trade accounts for more than 60 per cent of global trade in value-added terms, reflecting the unceasing importance of this phenomenon (World Bank, 2017)[2], which has attracted much attention among development economists and sociologists (Gereffi and Korzeniewic, 1994; Kaplinsky, 2000) and, more recently, has also captured the interest of international trade economists (Baldwin and Lopez-Gonzalez, 2015).

From the perspective of this article, the essence of the GVC approach is that the opportunities for building production and innovation capabilities in domestic enterprises are structured by the governance patterns that are dominant within international production chains. In other words, these opportunities, which shape the direction and speed of building domestic capabilities, vary according to how the chains are organised and governed (Schmitz, 2006, 2007). The array of relationships between the various actors involved in the chain—mainly the lead firms and the suppliers—is thus considered to have heterogeneous implications on domestic firms in developing countries (Gereffi, 1999; Humphrey and Schmitz, 2002). At any point in the chain, some degree of governance and coordination is required to make decisions not only on what should be done or how something should be produced but sometimes also regarding when and how much. Coordination may occur through market, hierarchy, modular, relational and captive relationships, based on three factors: (1) the complexity of the information involved in the transactions; (2) the possibility to codify that information; and (3) the competence of the suppliers along the value chain (Gereffi *et al*, 2005).

Pietrobelli and Rabellotti (2011) showed how different governance patterns heterogeneously impact the learning mechanisms in the chains: for instance, in modular chains, learning can be the result of pressure to match international standards, while in captive chains it may be facilitated by direct involvement of the value chain leaders if the competence of suppliers is low and the risk of non-compliance is high. Further, in relational GVCs, it can be mutual and based on intense face-to-face interactions when the actors in the value chain have complementary competences.

Learning and Innovation in GVCs

With respect to learning and innovation, the GVC approach presents three main shortcomings. The first is the missing conceptualisation and empirical investigation of the firm-level process of learning and innovation within a GVC (Bell and Albu, 1999; Morrison *et al*, 2008). The second is the relatively weak understanding of the role of the institutional frameworks and support organizations within this process (Whitley, 1996). The third is the still-nascent grasp of changes over time in GVC governance patterns and of possible multiple trajectories and stages of capability building involved in upgrading (Schmitz, 2007; Pietrobelli and Rabellotti, 2011). This introductory article, together with the other papers that are included in the special issue, makes contributions to fill these existing gaps in the literature.

Taking learning in GVCs into account, there is a wealth of evidence suggesting that global value chains offer an important opportunity to access and acquire foreign knowledge and technologies (see, for instance, Farole and Winkler, 2014; Cirera and Maloney, 2017). Of course, the innovation process requires a combination of external knowledge, absorptive capacity, namely the ability to exploit externally acquired knowledge (Cohen and Levinthal, 1990) and local innovation capabilities, both at the level of the innovating firms and of the local production and innovation system in which they are embedded.

In this respect, two important issues arise. Firstly, access to global value chains is uneven across countries and regions; while some parts of the world are considerable GVC hubs, other countries do not enjoy easy access to such international linkages (Plechero and Chaminade, 2016). Secondly, despite the opportunities generated by GVCs on account of the fact that local firms have to satisfy the product quality, delivery time and process efficiency, as well as the environmental, labour and social standards required by the leading companies, the precise nature of GVC inter-firm relationships and their impact on the learning for developing country firms' integration into global value chains remains rather controversial.

Our special issue offers insight into the mechanisms that enable learning and innovation in global value chains. As suggested by De Marchi, Giuliani, and Rabellotti (this special issue), the capability-building process is interactive and requires deliberate effort from a large range of actors, many of which are not directly included in (global) value chains. The more successful local firms that innovate do so because they make a considerable effort to build internal capabilities. Most importantly, they find that learning is most effective when GVC-related knowledge is used as a complement to other forms of local knowledge channels, such as collaborative learning within clusters and innovation systems, and when there are strong interactions with non-GVC actors such as local universities or business associations. Developing countries' firms' strong and close embeddedness in local, regional and national innovation systems is, therefore, often critical to the innovation process and international competitiveness.

A complementary perspective about learning within GVCs in which the protagonists of knowledge flows and technology transfer are not the lead firms but, rather, the suppliers is offered by Haakonsson and Slepniov (this issue). They present the case of the Chinese wind turbine industry and demonstrate how Danish component suppliers contributed to the process of building the technological capability of Chinese parts and components producers by transferring technology from the Danish to the Chinese wind innovation systems. This case study emphasises how opportunities for technological upgrading are not limited to a vertical context within GVCs and how firms can also leverage learning and innovation outcomes via horizontal collaboration.

Global value chain research has also shown that product and process upgrading may be facilitated in the initial stages of GVC development, but firms in developing countries may then hit a glass ceiling because functional upgrading in later stages may be contrary to the interests of powerful lead firms within the chain (Schmitz, 2007). To overcome these constraints, such as in the case of the Brazilian local furniture and footwear production and IS, Navas-Alemán (2011) shows how national and 'southern' value chains may offer better upgrading opportunities than global ones because they provide more space for higher-value activities (e.g. design, marketing, and branding). In the case of Korea and Taiwan, Lee *et al* (this issue) show that upgrading and achieving world-class leadership can be easier in short-cycle technologies in which the specific knowledge and the competence necessary to produce tend to change periodically and, therefore, incumbents have less accumulated technological advantages. They conclude that, for latecomers, the challenge is not only building capabilities, but also specialising in industries where entry barriers are lower and learning and growth prospects are higher.

Measuring the Importance of GVC Participation

The insights discussed above are mainly based on qualitative studies regarding specific sectors in selected countries. Such case-based research methodologies have been common to the GVC

literature, identifying knowledge inputs and processes that support upgrading and innovation on an individual basis (Jurowetzki *et al*, this issue).

Complementing this approach, the more recent availability of multi-country input–output databases[3] has increasingly allowed for the measure of cross-border value-added flows across countries and industries, mapping the value-added generation process of every product in every country at every GVC stage (World Bank, 2017).

In this special issue, Tajoli and Felice explore the role of intermediate inputs in knowledge transfer, investigating whether GVC participation can lead to international knowledge spillovers of a kind that significantly affect a country's innovation performance (as measured by patents per capita) in a large sample of countries at different stages of development. Their results suggest that sourcing inputs serves as a mode of technology transfer across GVCs when they are imported from high-income countries. Moreover, although GVC participation can push developing countries to specialise in low innovative content, they find that the potential for knowledge transfer and spillover effects is the greatest when countries are at intermediate stages of development.

Developing Country Innovation Systems in the Global Economy

The innovation system approach has emerged as an important policy tool to understand what forms of national institutions and capabilities broadly account for competitiveness. Rooted in the tenets of evolutionary economics, a system of innovation is the sum of all market and non-market actor networks that foster the creation, transfer, adoption, adaptation and diffusion of knowledge through learning processes that are individual, collective and organisational (Oyeyinka and Gehl Sampath, 2007).

The main hypothesis of the IS approach is that innovative capacity at the firm level depends on the density and quality of the relationships among enterprises and between enterprises and supporting institutions (Lundvall, 2007). However, when we consider the IS approach from the point of view of building innovation capabilities in developing countries, there are some main weaknesses to note. First, the approach originally emerged by analysing advanced economies in the triad of Europe, Japan and United States (Freeman, 1987; Lundvall, 1988; Nelson, 1993), with most attention originally given to relatively mature innovation systems (Adebowale *et al*, 2014). Second, it is mainly focused on internal system dynamics, with a less developed analytical grip on the relationships to key actors from outside the region or country. As a matter of fact, much IS theory and policy has adopted a perspective of methodological nationalism, giving insufficient attention to extra-national learning channels, including global value chains (Jurowetzki *et al*, this issue). Third, there is still an underdeveloped understanding of the dynamics of innovation systems (i.e. changes over time) and the possible trajectories that can help countries to promote dynamic industrial development.

In this section, we discuss how research in the IS tradition has (recently) addressed the role of external linkages and dynamics (especially in developing countries) more explicitly, then we link back to the insights of the prior section on GVCs by demonstrating how some of the articles in this special issue push the discussion forward.

Dynamics of Building Innovation Capabilities in Developing Countries

As indicated above, the innovation system approach developed originally from the study of advanced economies, but over the last decade increasing attention has been given to the role of

innovation system in developing countries (e.g. Lundvall, 2007). Three important insights emerge out of this literature. First, in developing countries, it is important to '*find your own way'*, without employing advanced economies' experiences as models (Adebowale *et al*, 2014; Lundvall and Lema, 2014). Second, the notion of an IS should be rather broad, closely integrating incremental innovation and collaborative learning and going beyond a narrow interpretation of innovation as the outcome of science-based research (Metcalfe and Ramlogan, 2008). Third, in developing countries, innovation systems are often characterised by weak and fragmented relationships among enterprises and between enterprises and supporting institutions. Therefore, as suggested in Ernst (2002), they should rely on both international and domestic knowledge sources to complement and strengthen production and innovation systems, which may initially be very weak (see also Chaminade and Plechero, 2015).

In developing countries, the internationalisation of production and innovation system is further reinforced by the fact that constituent enterprises and other actors are increasingly inserted into GVCs and innovation networks that span national borders; therefore, innovation systems are permeable and contain multiple links into the global economy (i.e. the system is open). Drawing on her research on China, Fu (2015) highlights some important aspects that characterise an open innovation system. First, there is a combination of domestic and foreign innovation sources that concurrently builds on internal and external knowledge that co-evolves over time. National actors foster domestic innovation capabilities that are needed to open, absorb and adapt external knowledge or resources. Second, global knowledge sourcing is bidirectional, involving both inward and outward flows of knowledge and resources. Third, the combination of knowledge-sourcing channels is dynamic and the balance between outward and inward knowledge flows changes over time and at different stages of innovation and development.

The experiences of several countries, such as China and South Korea, show that the formation of dynamic innovation systems is crucial to overcoming capability failures and transitions from trade-based specialisation in labour-intensive exports to sustained knowledge-based competitiveness in the global economy (Lee, 2013). In this respect, the very relationship between the innovation system and the global economy may change significantly in sequential stages. While List (1856), who was the first to introduce the concept of a national political economy system, is often remembered for his arguments in favour of protectionism, it is commonly overlooked that he combined ideas of national (systems of) technological development with a dynamic approach to infant industry protection and international trade, alternating between protectionism and international competition over the course of national development stages.[4]

In sum, the role of external linkages from local and national innovation IS to the global economy is likely to change in both quantity and quality during the development process. Such a dynamic approach, taking into consideration the international dimension of innovation systems, is particularly significant when considering the co-evolution of global value chains and innovation systems since processes of building capabilities are unique to each country and context and require a confluence of local, national and international factors.

The Role of Innovation Systems in the Era of Global Value Chains

This special issue addresses, in several contributions, the role played by the innovation systems in supporting the development of domestic capabilities and in meeting the requirements for gaining benefits from participation in GVCs (Pietrobelli and Rabellotti, 2011).

Keijser and Iizuka (this issue) stress the key function of innovation systems in mobilising domestic resources to assist local firms in gaining competitiveness in local, regional and global value chains in their analysis of the South African information technology-enabled services sector. They find that firms with strong internal resources (larger and mostly foreign firms) manage to become directly integrated into GVCs, whereas most of the local firms participate in local and regional chains. Therefore, government policies that prioritise incentives to GVCs to promote foreign direct investments and create widespread employment may be a good short-term strategy that is potentially detrimental to the development of capabilities in the longer run because smaller domestic firms suffer from a lack of support at the innovation system level.

Participation in local and regional chains implies that firms experience fewer immediate learning effects (especially in terms of knowledge transfer and the development of skills from client firms or GVC counterparts). In some cases, the firms engaged in such value chains are able to strengthen their position in the local and regional markets through internal (in-house) resources, which helps them to enter GVCs in a later stage. However, they also find that many firms in local and regional chains do not manage the leap because of a lack of support from the innovation systems in alleviating resource constraints and supporting the attainment of competitiveness. Accordingly, they call for stronger innovation systems to facilitate inter-chain upgrading (from local to regional to global value chains) in the longer run.

The positive role of policy in creating new channels to tap into foreign knowledge is also confirmed in the already-mentioned case study on the wind industry in China. Haakonsson and Slepniov (this issue), found that a change in the Chinese industrial policy, the introduction of a local content requirement, was a turning point for the Danish component suppliers who followed the Danish lead firms into the Chinese market, thus creating new horizontal linkages and technology exchange between Danish and Chinese firms.

While such linkages may be beneficial to capability development, there is still a lot of ambiguity as to what might be a good framework that is supportive of learning and innovation through GVC participation in the policy community. Adopting a value chain perspective can help policy makers to concentrate on a particular stage of the value chain in which a local enterprise has potential, then uses this as a springboard for either vertical or horizontal expansion. Assessing the variety of interventions suggested by international organizations and donors, Pietrobelli and Staritz (this issue) make the case for more informed policy making based on the core concepts of GVCs, their drivers and their power and governance structures.

Underscoring the same point, Jurowetzki *et al* (this issue) show how combining the existing insights of the GVC and IS approaches is essential to building a more useful knowledge base for action. According to a detailed appraisal of the existing literature, they argue that countries that managed to successfully catch up (such as South Korea and China) have considered both the need to strengthen their innovation system and to engage in, and upgrade through, GVCs. They conclude that more work is needed to understand what the key, dynamic points of balance are in terms of the type and degree of value chain insertion and the domestic strength of the innovation system.

Measuring the Importance of Innovation Systems

Econometrically, the importance of the innovation systems is verified in three quantitative studies that are included in the special issue. In the already-mentioned article, Tajoli and Felice (this issue) emphasise the supporting role played by institutions and policies in developing countries—particularly those that improve absorptive capacity, provide industrial support and

technology incubation and support patenting—in enabling them to maximise the benefits from GVC participation.

Further evidence is offered by Gehl Sampath and Vallejo (this issue) in their empirical analysis of 74 developing countries (with over 30 least developed countries) from 2000 to 2010 in which they find that while some countries manage to export across a large number of technological export categories (Lall, 2000), many other countries in the sample remain embedded in the export of low technology goods with little movement into other technologically complex categories. The analysis shows that the main distinguishing factor that accounts for the success of some developing countries is the presence of a strong innovation system. In those countries that managed to technologically diversify, firms were able to rely on and leverage knowledge flows within and outside the GVC to build export capacity and diversify horizontally into new GVCs. In particular, they found that two variables related to the innovation systems—public R&D expenditure and scientific and journal publications—have a weakening link with firm-level indicators of innovation capacity, such as patents by residents and licensing of intellectual property, thereby weakening the capacity of local firms to expand into new technological sectors through GVC participation.

Fagerberg *et al* (this issue) similarly conclude that there is a strong link between developing technological and social capabilities and economic development. They infer from their cross-country empirical analysis on 114 countries at different level of development that building the innovation system is not only important for economic development more generally but also for the possibility to benefit from GVC participation.

The Co-evolution of Global Value Chains and Innovation Systems

The innovation system and value chain approaches are relational in nature and complement each other by focusing on a variety of possible relationships between heterogeneous actors. However, they do not provide much understanding of dynamics, which is necessary in order to focus on the interactions of local and global linkages. This section proposes a novel framework that highlights the co-evolution between global value chains and innovation systems to explain the dynamics of building innovation capabilities at the firm level and illustrate possible trajectories in which such capabilities might evolve.

Figure 1 presents the co-evolutionary relationships in which local firms are involved with global value chains and innovation systems. There are flows (dark and light grey arrows) indicating how they contribute to the accumulation of firms' capabilities and learning processes, as well as feedback (black arrows) that identifies how global value chains and innovation systems co-evolve, thanks to their interactions with local innovative firms and their evolving capabilities.

The interactions between global value chains and local firms (dark grey arrows) can involve knowledge about product requirements in the global markets, technologies (know-how, licenses or other means), organisational models and even direct support from the leading GVC companies, depending on the main governance patterns. Subject to the strength of the system, the flows between the innovation systems and the local firms (light grey arrows) could provide specialised skills and knowledge, extension services such as metrology, standard certifications or incubation services, financial resources, and local research inputs mainly based on adaptations of existing knowledge.

The black arrow (left side) indicates that changing local firm capabilities influence where and how they can engage in different types of GVCs (e.g. in different markets), taking into

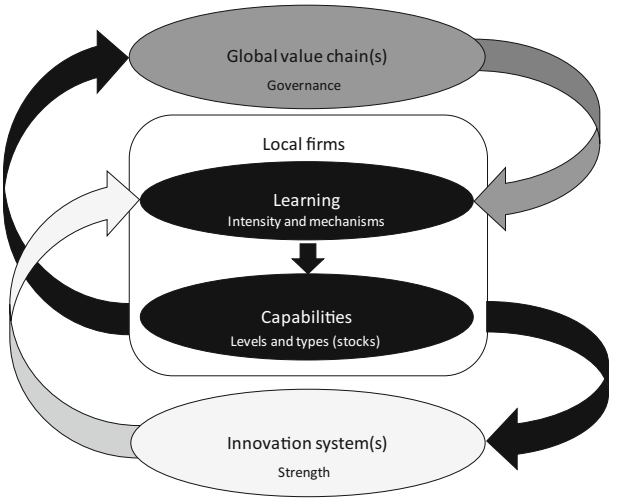

Figure 1: GVC-IS co-evolution and firms' innovative processes.
Source: Authors' elaboration.

account their competitive dynamics. Changes in local firm capabilities, arising from local and global learning processes, may influence the governance structures of GVCs (Gereffi *et al*, 2005), including the sourcing strategies of the lead firms (Lema, 2012, 2015). On the right side, the black arrow points to the relative stock of capabilities in local firms inserted in GVCs that influence the evolution of the innovation system. This may happen because of the demand for different types of knowledge and resources in the education and science system or because of specific services offered by quality and standard agencies, business associations, etc. In addition, there may also be spillovers in the form of demonstration effects or labour rotation, as well as various kinds of forward and backward linkages within the innovation system.

As is evident in Figure 1, at the centre stage there are local firms, which are the main actors of the innovation process. Their role is determined by internal knowledge and capabilities as well as external knowledge acquired via interactions with many other stakeholders, among which we focus here on those within global value chains and innovation systems. Of course, there may also be other forms of interactions between chains and systems that are not captured in Figure 1. For example, there are sometimes more direct links between global value chains and innovation systems when multinational firms integrate into local systems, contributing to the process of shaping the industry dynamics. While acknowledging such direct links, our focus is mainly on the co-evolution of system/chain relationships involving local firms.

It should be noted that there is no automaticity in these interactions and their effects. They may not arise at all or may be severely constrained. The specific nature of co-evolution of global value chains and innovation systems will also vary greatly, depending on an assortment of macro- and micro-factors. These include the level of development and governance capacity of the country, the macro-economic context, the trade policy framework, the main market segments, the existence and development of other external channels (e.g. FDI, human capital mobility, direct exports), the technological characteristics and knowledge bases of the predominant sectors and the characteristics of local firms (e.g. size, openness, presence of knowledge gatekeepers, level of formality). Also, depending on such factors, co-evolution

between global value chains and innovation systems will unfold in a large array of context-specific trajectories.

In the next subsection (Stages of GVC–IS co-evolution), we propose three possible stages of the co-evolutionary process, based on (1) the dominant governance patterns in the GVCs, (2) the strength of the IS, and (3) how global value chains and innovation systems jointly contribute to the accumulation of firms' innovative capabilities and learning processes. Then, in the subsection that follows (Illustrative trajectories), we suggest four illustrative trajectories, which are possible combinations involving all or some of these stages. It must be emphasised upfront that these stages and trajectories are stylised cases for illustrative purposes. In reality, however, certain phases and development processes may vary or even diverge to reveal new pathways. This effort, therefore, is not to limit the co-evolutionary scope to these four alternatives but to provide a discussion of paths and their stylised changes over time with the aim to facilitate the conceptualisation of the interactions between global value chains and innovation systems.

Stages of GVC–IS Co-evolution

In the *preliminary development stage*, there is not yet a fully formed production system, and certainly not an innovation system, but only pockets of efficiency enabling basic capabilities that are required as an entry ticket for initial involvement in GVCs. Nevertheless, the existence of even a very weak and fragmented innovation and production system provides important functions, such as basic skills formation and the availability of some hard and soft infrastructures. In this stage, the system formation process may benefit from the improvement of production capabilities in the globally connected enterprise segments, thanks to demonstration effects, labour rotation, knowledge spillover and private sector investment capacity increases.

This stage sees the initial insertion into GVCs, typically exploiting low costs of labour or the availability of natural resources. Local suppliers are low skilled, and the most diffused patterns of governance are captive or hierarchical ones. Lead firms actively intervene in the learning process of their local suppliers or subsidiaries that often lack competences and, through their supervision, they may strengthen local production and organisational capabilities, increasing productivity and the capacity to cope with the international market. However, their support is usually confined to a narrow range of tasks, such as simple assembly; therefore, there is a risk of lock-in, given that the lead firms do not sustain the development of strategic, core capabilities needed for innovating. In some cases, such as the IT providers in South Africa described by Kejser and Iizuka (this issue), regional and local value chains can offer an easier opportunity to learn and acquire some initial production capabilities, which can be leveraged to move towards future stages.

In the *expansion and strengthening stage,* the nature of GVC insertion changes as prior capability-building (in the *preliminary development stage*) enables further strengthening of local capabilities and absorptive capacity. The range of governance modes in use may expand to include modular or relational types. In modular chains, suppliers learn how to produce components and parts to fully specified technical standards. Lead firms impose pressure on their suppliers to keep abreast of technological advancements, but do not become directly involved in the learning process. In addition, positive knowledge externalities may result for the rest of the economy. Quite differently in relational value chains, transactions are complex and not easily codified and firms have highly complementary competences. Therefore, local learning is the result of very tight, face-to-face interactions. Beyond firms directly involved in GVC, there

is commonly technology spillover, as well as increased demand for skilled labour and locally produced inputs (Amendolagine *et al*, 2017).

In both cases, denser and more coherent innovation systems are required to supply more complex and knowledge-intensive support services. Functioning vocational training institutes are key to strengthening the capability of firms involved in GVCs. The formation of stronger enterprise capabilities may create further demand for knowledge provision in the strengthening of ISs, in which investments in human capital for engineering and design become crucial. Again, knowledge accessed through the involvement in GVCs and the direct involvement of lead firms, particularly in the case of relational GVCs, can contribute to deepen the IS. In addition, GVC participation can stimulate investments in infrastructures and in the development of services that would otherwise not be profitable (Taglioni and Winkler, 2016).

In the *maturity stage*, the demand for knowledge creation is increasing as world-class capabilities need nurturing and support. The deepening innovation system becomes stronger and more dynamic. The flow of information, knowledge and technology among individuals, enterprises and institutions become denser and more varied. These exchanges are further strengthened when governments design and implement tailored innovation policies and invest in R&D institutions and tertiary education to create a world-class workforce while also globalising the IS through international innovation networks (see Fu and Gong, 2011, for the case of China).

This is a long time-horizon stage for firms and countries able to directly connect to lead markets and anticipate future customer needs, including those of end users. Firms in developing countries may also take on coordination tasks—thereby significantly shaping cross-border value chains. Local firms are in direct relationship or might even become leading companies in GVCs. This may happen more easily in short-cycle technologies because barriers are lower, given that they require competence and knowledge that is rapidly changing, in which incumbents have lower technological advantages (Lee *et al*, this issue). Intensive two-way knowledge flows underlie value chain relationships as firms transition from problem-solving to problem-framing, sometimes based on research and development capabilities. A fully formed innovation system and extant innovation capabilities allow for the broadening, deepening and shifting of value chain engagements.

Illustrative Trajectories

In this section, we describe four hypothetical trajectories of GVC-IS co-evolution, based on some of the potential combinations of the three stages introduced in 4.1. We call them: (1) the *gradual*, (2) the *in–out–in*, (3) the *aborted*, and (4) the *retrograding* trajectories. Table 1 offers a summary of their main characteristics with reference to the stages involved, firms' capabilities and the main features of global value chains and innovation systems.

The *gradual trajectory* results from a positive co-evolution between GVCs and ISs when the local firms move on from the *preliminary development* stage to the *expansion and strengthening* phase, eventually reaching the *maturity* stage. This path occurs when the local innovation system has the prerequisite strength and the value chain characteristics allow for knowledge flows and interactive learning. The literature offers several examples in which such pathways have been forged, not least in large middle-income countries with relatively high governance capacity. Altenburg *et al* (2008) show how innovation systems, together with knowledge acquired within GVCs, have contributed to the attainment of innovation capability in China and India in diverse industries such as space, electronics and automobiles. They show that '*global linkages were flanked by considerable investments in domestic innovation systems,*

Table 1: Illustrative trajectories of GVC–IS co-evolution

Trajectories	*Firm capabilities*	*Innovation system(s)*	*Value Chain(s)*	*Examples*
Gradual (From *Preliminary Development* through *Expansion and strengthening* to *Maturity*)	Firm capabilities gradually and cumulatively strengthened	Innovation system sufficiently strong and strengthened by GVC involvement	Value chains expand and strengthened with more rewarding and learning-intensive roles	**Chile:** salmon **China and India:** electronics, car & space industry **China:** mobile phone and electric two-wheeler
In–out–in (From *Preliminary Development* to *Maturity*, skipping *Expansion and strengthening*)	Firm capabilities strengthened in successive jumps; firms oscillate between GVC and IS as alternate sources of knowledge and capabilities building	Innovation system sufficiently strong to support value chain development	GVCs fail to provide learning opportunities; interrupted value chain development; sequencing of local and global value chains	**Brazil:** footwear **India:** pharmaceuticals **Korea:** toys, musical instruments and helmets
Aborted (Stuck between *Preliminary Development* and *Expansion and strengthening*)	Firm capabilities unchanged or marginally developed	Innovation system fragmented and unable to support value chain development; limited absorptive capacity	Value chain participation stagnant; limited learning in key tasks	**Bangladesh:** aquaculture **Kenya, Lesotho and Swaziland**: textiles
Retrograding (Reverting from *Preliminary Development* to reduced innovation capacity)	Firm capabilities weakened	Very weak innovation system unable to support value chain development; negatively affected by lead firms with strong bargaining power	Change of or exit from value chain	**Gabon**: timber **Thailand:** cassava

Source: Authors' elaboration.

especially in R&D and the development of advanced skills. Both governments have shown a clear commitment to science and innovation, define sector-specific technological targets and allocate resources accordingly' (Altenburg *et al*, 2008, p. 337).

Another example is the salmon industry in Chile, where the involvement in the GVC has created a demand for knowledge in biochemistry and related science fields, as well as for engineering-educated technicians, which has been successfully addressed by the strengthening of the local innovation system (Rainbird and Ramirez, 2012; Hosono *et al*, 2016). Although in the literature there are many other empirical cases showing how ISs and value chains have combined their strengths to support learning and innovation in developing countries (Chaminade and Vang, 2008; Sun *et al*, 2010; Zhang and Gallagher, 2016), there are still relatively few insights on how the feedback effects indeed work (e.g. how such positive co-

evolution has further contributed to strengthen the innovation systems and impacted the country, region or local position in the GVC).

Humphrey *et al* (this issue) shed light on some of the factors that can support the emergence of a *gradual trajectory*. They show how the rapidity and complexity of technological change—either due to the technology characteristics of some sectors (technology push factor) or the nature of demand (demand pull factor)—create opportunities for more intense interactions between global value chains and innovation systems. They analyse the drivers of product differentiation and innovation in two very different sectors in China (the mobile phone and electric two-wheeler), highlighting the role of policy in supporting the GVC–IS co-evolutionary trajectory. The authors note that, although changing customer demand created the pressure to improve functionality and quality of products in the Chinese market, in both sectors, public policy supported the development of capabilities. The electric two-wheeler sector expanded rapidly due to governmental restrictions on gasoline-led motorcyles. So, although the technological change was much slower, the domestic policy helped Chinese firms to secure greater shares of an expanding market by investing greater R&D capabilities, while, at the same time, benefiting from extensive support from the national innovation system. In the mobile phone sector, where technological change was rapid and of a disruptive nature, firms similarly benefited from public policies that supported capabilities development. Their findings reinforced how firm-level and publicly-led investments in innovation capabilities work together to promote innovation.

The *in–out–in trajectory* may unfold if the innovation system is relatively well developed, but GVCs are characterised by limited learning opportunities. Lee *et al* (this issue) present evidence supporting this trajectory, using cases of Korean and Brazilian firms. They suggest that (1) participation in the GVCs is necessary to acquire foreign knowledge and production skills in the *preliminary development* stage (2) separation and independence from existing foreign-dominated GVCs is required for functional upgrading at mid-level stages, and (3) latecomer firms and economies need to reintegrate into the global chain after establishing their own local value chains, ultimately reaching the *maturity* stage. According to them, new technologies, and more precisely short-cycle technologies that rely less on existing knowledge stocks, offer better opportunities for latecomer countries to achieve world-class competence.

Navas-Alemán (2011), in the already-mentioned study on the footwear industry in the Sinos Valley, which is also one of the cases mentioned in Lee *et al* (this issue), provides further evidence on this trajectory, finding that local suppliers were discouraged from functional upgrading by their main U.S. buyers, who did not want to share their core competencies in design, marketing and sales with them. The building of local design capabilities has been achieved by those firms that decided to opt out from the U.S. GVC, focusing on the national and then regional Latin American market. Thanks to the support offered by the *Made in Brazil* program, such firms were promoted by the local business associations. According to Navas-Alemán (2011), in this case domestic and regional value chains offered more opportunities for learning: '*The upgrading attainment shown by many firms in this study shows that it is possible to harness the potential of global, domestic, and regional markets to master all types of upgrading needed to compete in the global economy'* (Navas-Alemán, 2011, p. 1395).

Examining the Indian pharmaceuticals case, Horner (2014) offers another interesting example that demonstrates how selective and short-term strategic *decoupling* and subsequent *recoupling* from the GVC has played an important role in the upgrading of the industry. Decoupling in the sector began in the 1970s and involved the establishment of disincentives for imports of medicinal formulation while, at the same time, promoting product and process innovation among domestic firms catering for the local market. In the 1990s, following an

economy-wide liberalisation process, the policy regime for pharmaceuticals was liberalised. The relationships with the multinational pharmaceutical companies was re-negotiated and state support for recoupling enabled a phase of growth, involving product and process R&D, thus increasing contract manufacturing service for MNCs in generic production and sales of branded products to developing country markets.

The *aborted trajectory* may occur if the innovation system is relatively weak and fragmented and the value chains do not provide access to critical knowledge, resources and pressure for learning. In this case, after the *preliminary development* stage, the local firms remain stacked somewhere between this stage and the following one, thereby failing to reach the *maturity* stage. Learning rates are slow and knowledge does not transmit or spill over from GVC enterprises to the wider innovation system, due to limited local absorptive capacity. There is ample evidence on such aborted trajectories where the involvement in GVCs fails to generate improved local innovation capabilities. For example, Ponte *et al* (2014) investigate the aquaculture chains in four Asian countries, finding that—in contrast to producers in China, Vietnam and Thailand, where functional upgrading occurred—Bangladesh lacked sufficient quality and capacity with respect to the domestic regulatory framework and public sector support, which meant that upgrading attempts were unsuccessful. Due to government subsidies for processing plants in the shrimp and prawn chains, there was little incentive to invest as plants were able to operate at lower efficiency levels than in competing locations. Moreover, global value chains themselves provided inadequate knowledge and resources for meeting international food safety standards through the implementation of quality controls, partly because traceability norms were not enforced. This combination of local weaknesses with little GVC involvement clearly impacted the ability of the local industry to improve.

In their analysis of the apparel sector in Kenya, Lesotho and Swaziland, Staritz and Frederick (2014) focus on GVC linkage and spillover effects, showing how such effects were constrained by limited absorptive capacity. While these countries succeeded in attracting Asian FDI, a scarcity of local manufacturing firms translated into an inability to absorb spillovers through demonstration and collaboration effects. The low capability levels did little to elicit the interest of foreign-owned firms in establishing interactions and linkages, and the main reason for their involvement in these countries was the possibility to export to the U.S. market under the AGOA preferential treatments (Morris and Staritz, 2017). Furthermore, few opportunities for learning and innovation arose due to external control of supply chains. Reliance on foreigners for management and technical tasks in these chains constrained knowledge spillovers and inhibited local entrepreneurial responses and learning processes.

The *retrograding trajectory* may occur if the innovation system is too weak to sustain competitiveness in GVCs, and changes in the GVCs and in global demand occur. This is the case of the cassava industry in Thailand analysed by Kaplinsky *et al* (2011), where the shift from the EU market to the GVC targeting the Chinese market has caused a change in product forms from pellets to chips. This transition has led to a reduction in the degree of processing, given that chip production is a labour-intensive operation with very low added value; pellet production builds on chip production, adding value by grounding, stemming and moulding chips into pellets. A similar case is described by the same authors in the Gabon timber industry. In this case, due to the entry into the international market of China and the shift from exporting processed logs to the EU to unprocessed logs (under strict environmental standards), the focus changed to quantity rather than quality, thus reducing processing and even leading to some compelling evidence of illegal exports. These examples show how the local production and innovation system may be unable to prevent footloose sectors from relocating or responding to external competitive threats arising from the entry of competitors into the world market. In such

cases, the local businesses may be squeezed out from GVCs and lose some of their capacities, moving down the technological chain.

Final Remarks

There is widespread agreement that the insertion of firms from developing countries into global value chains and innovations systems influences the building of technological and innovation capabilities, both at the firm level and at different geographical scales (Hausmann *et al*, 2007; Lundvall *et al*, 2009; Nübler, 2014). There have been prior attempts to bring these frameworks together for theory building and empirical analysis (Altenburg *et al*, 2008; Pietrobelli and Rabellotti, 2011), but there is still a need for progress on the dynamics involved. The key point is that the GVC and IS approaches complement each other by helping to address the relationships with (different) actors that impact the process, but, on their own, neither framework is sufficient to provide a full understanding of the underlying dynamics. This article has, therefore, sought to address a key question in this nexus: how can GVC and IS approaches be combined to help us understand potential trajectories and stages of innovation capability building?

Each of the papers in this special issue, containing original quantitative and qualitative evidence, further the existing literature on the topic by offering new insights into how learning and innovation takes place in GVCs in developing countries; investigating the role of innovation systems (and policy) in ensuring benefits from participating in global value chains and also pointing to the different ways in which global value chains and innovations systems co-evolve in countries and sectors to enhance learning and innovation.

In the framework proposed in this paper (see the section entitled 'The co-evolution of global value chains and innovation systems'), we distinguish between three potential stages of the co-evolution process (*preliminary development*, *expansion and strengthening* and *maturity*) that are linked with four different illustrative (*gradual*, *in–out–in*, *aborted* and *retrograding*) trajectories of GVC–IS co-evolution. Obviously, trajectories in the real world may not always fit within those illustrated here in a stylised way. The suggested framework is tentative and intended to highlight the multiplicity, diversity and nonlinearity of possible pathways. They provide a basis to structure future analyses on GVC and IS dynamics, certainly unearthing variations of the illustrative pathways presented here and possibly adding entirely different trajectories. This is an area where more empirical research is strongly needed, with a focus on documenting and providing robust evidence on how GVC and IS co-evolve and support (or undermine) each other within different sectors, local contexts and countries at different levels of development.

This special issue is a first step in that direction. It is intended to offer important inputs to stimulate a debate on how policy should be structured to combine domestic and foreign sources of knowledge to promote innovation capacity and economic development. There is not only a need to move away from policies that automatically assume a positive effect of GVC involvement for learning and capabilities building but also an urgency to proactively engage in combining global value chains and innovation systems as two complementary instruments for sustainable economic development.

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Notes

1. Since the 1990s, the increasing openness of economies is evident in the value of imports and exports, which now supersedes goods and services that are domestically produced and consumed. After high-income countries (where, in 2016, trade openness reached 60 per cent), low-income countries are, on average, more open to trade, with the sum of total exports and imports reaching 58 per cent of GDP, than lower-middle-income countries (51 per cent) and upper-middle-income countries (47 per cent) (www.data.worldbank.org/indicator accessed on 26 March 2018).
2. This estimation confirms the importance of GVC trade, notwithstanding that, since the financial crisis, GVC increase has stalled for three main reasons: the rise of protectionism around the globe; the increased domestic production capacity in emerging economies, such as China; and the mounting reshoring phenomenon, especially in the United States.
3. Among the most used databases are Eora Multi-Region Input–Output (MRIO), which covers 189 countries from 1990 (Lenzen *et al*, 2012), used by UNCTAD (e.g. UNCTAD, 2013) and IMF (e.g. IMF, 2016); the OECD-WTO Trade in Value Added (TIVA) with information on 63 economies from 1995 and the World Input–Output Database (WIOD), initially funded by the European Commission, on 43 countries starting from 2000. We should also mention that the World Bank has recently also made available a new database for in-depth tracking of merchandise trade in the GVC for apparel/textile, electronics, and motor vehicles and parts (Ferrantino and Schmidt, 2018).
4. List adopted a three-phase prescription where countries should tailor their systems according to the measure of their own progress in industrial development: 'In the first stage, adopting free trade with more advanced nations as a means of (…) making advances in agriculture; in the second stage, promoting the growth of manufactures, fisheries, navigation, and foreign trade by means of commercial restrictions; and in the last stage, after reaching the highest degree of wealth and power, by gradually reverting to the principle of free trade and of unrestricted competition in the home as well as in foreign markets, that so their agriculturists, manufacturers, and merchants may be preserved from indolence, and stimulated to retain the supremacy which they have acquired.' (List, 1856, pp. 141–142).

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